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JUNE 29, 1973

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HS-012 680; HS-012 705-731; HS-012 733-768

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U.S. Department of  
Transportation

National Highway  
Traffic Safety  
Administration



*Shelua in stacks  
S.B.T.*

# Highway Safety Literature

... A SEMI-MONTHLY ABSTRACT JOURNAL

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**Corporate author:** Contact corporate author.

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A document containing several articles is announced as complete volume under an HS number referring to it as a whole. Entries for individual articles are listed under their own HS numbers.

## SAMPLE ENTRIES

### JOURNAL ENTRY

**Title of Document** { **SYNTHESIS OF CASE LAW JURISPRUDENCE RELATING TO WET-WEATHER HIGHWAY CONDITIONS**

**Journal Citation** → Highway Research Record n 376 p29-36 (1971)

**Author(s)** → D. C. Oliver 1971

Sponsored by Highway Res. Board Steering Com. for Workshop on Anti-Skid Program Management and presented at the workshop.

**Search Terms** { Descriptors: \*Liability, \*Negligence, \*Accident responsibility, \*Legal responsibility, \*Wet road conditions, \*Court decisions, \*State government, \*Skidding accidents, \*Warning signs, \*Highway maintenance, \*Litigation, \*Icy road conditions,

**Abstract** { The extant case law on legal liability for accidents occurring on icy and wet highways has established three central areas and one subarea in the jurisprudence of maintenance liability. These areas are compliance with general duties in order to escape liability; damages resulting from noncompliance (negligence); contributory negligence as a bar to recovery; and advisory signing as a technique in meeting general duties. Court decisions covering these four areas are presented.

**NHTSA Accession Number** → HS-012 289

\*Subject heading in Subject Index

### CONTRACT REPORT

**EQUIPMENT AND PROCEDURES FOR MEASURING GLARE FOR MOTOR VEHICLES. FINAL REPORT**

**Corporate author** → Teledyne Brown Engineering

**Availability** → N. E. ChattertonJ. D. HayesE. W. George 1972 102p

Contract DOT-HS-089-1-139

NTIS

Descriptors: \*Glare, \*Glare reduction, \*Visual perception, \*Photometers, \*Luminance, \*Hydraulic equipment, \*Central vision, \*Field of view, \*Backgrounds, \*Contrast, \*Light conditions, \*Brightness, \*Test facilities, \*Test equipment, \*Vehicle safety standards, \*Simulators, \*Light, \*Reflectance, \*Measuring instruments,

A procedure and description of equipment for measuring glare from a driver's own vehicle are presented. The procedures are based on a disability glare theory as applied to foveal vision. Two pieces of apparatus were constructed to provide the measurement capability. One of them simulates diffuse sky glare and the other simulates direct solar glare. Methods of combining data from these measurements are presented along with scaling laws selected to provide a value for glare as it would be under natural daylight conditions. A standard for allowable glare levels from the vehicle is developed which is independent of the measurement procedure. Test results from a passenger car are presented and compared with this standard. Recommendations for improvements to the apparatus and additional research requirements for improvement to the theory are made.

HS-800 731

\*Subject heading in Subject Index

## 1. ACCIDENTS

### 1C. Investigation And Records

#### STATISTICAL ANALYSIS OF CHILD PEDESTRIAN ACCIDENTS IN MANCHESTER AND SALFORD

For primary bibliographic entry see Fld. 3K.  
HS-012 680

### 2. HIGHWAY SAFETY

### 2G. Meteorological Conditions

#### INTERNATIONAL AUTOMOBILE TECHNICAL CONGRESS OF FIATA (14TH) 25-30 JUNE 1972, LONDON

Institution of Mechanical Engineers (England)  
For primary bibliographic entry see Fld. 5F.  
HS-012 743

#### THE MANY ASPECTS OF DIESEL ENGINE NOISE

W. M. ScottPaper-1/1  
See serial citation

\*Engine noise, \*Diesel engines, \*Noise control, \*Engine tests, \*Idling, \*Fuel injection, \*Combustion, \*Engine design, \*Engine modification, \*Acoustic measurement, \*Engine performance, \*Gear design, \*Fuel pumps, \*Torque, \*Loading (mechanical), \*High speed, \*Knock,

Competition with the gasoline engine prompted investigations into ways of reducing diesel engine low speed idling noise. Tests are described to separate and assess the relative contributions of combustion, fuel injection, and mechanical sources, and design modifications to reduce noise are investigated. The value of these modifications is considered in relation to the present need for noise reduction at high speeds and loads. In addition to giving quieter idling engines, these modifications together with other means will be required to meet progressively more severe noise regulations.  
HS-012 744

#### COMMERCIAL VEHICLE EXTERIOR NOISE

P. E. WatersPaper-1/4  
See serial citation

\*Vehicle noise, \*Commercial vehicles, \*Noise sources, \*Acoustic measurement, \*Performance tests, \*Speed, \*Sound intensity, \*Power, \*Diesel engines, \*Tire noise, \*Mathematical analysis, \*Loading (mechanical),

The characteristics of commercial vehicle noise sources are summarized, and the way in which these characteristics determine those of overall vehicle noise is shown. It is concluded that a simple model of the vehicle as a number of coincident, coherent point sources is adequate for understanding noise emission, which it predicts to within plus or minus 2 dB (A). The constant-speed, drive-past-noise characteristics of some vehicles are discussed. It is concluded that the noise of most commercial vehicles is governed by the power unit.  
HS-012 747

#### SUSPENSION DESIGN TO REDUCE INTERNAL ROAD NOISE

For primary bibliographic entry see Fld. 5R.  
HS-012 748

#### PISTON MOVEMENT AS A SOURCE OF ENGINE NOISE

A. M. LawsD. A. ParkerB. TurnerPaper - 1/6  
See serial citation

\*Engine noise, \*Noise sources, \*Pistons, \*Cylinders, \*Engine design, \*Vibration, \*Engine blocks, \*Compression, \*Piston engines, \*Loading (mechanical), \*Engine speeds, \*Operating temperature, \*Diesel engines, \*Engine tests, \*Measurement, \*Noise control,

The importance of piston slap as an identifiable component of engine noise is liable to increase as progress is made in reducing other noise sources. Results from simultaneous measurements of cylinder-block vibration and piston-liner clearance in a four-cylinder gasoline engine showed that piston slap can be reduced by decreasing the lateral and rotational velocities of the piston. A comparison of calculated and measured movements showed that continued development of the calculating program to include the effects of finite skirt and liner stiffness offers the possibility of minimizing the severity of piston slap at the design stage.  
HS-012 749

#### NOISE FROM DIESEL FUEL INJECTION EQUIPMENT

M. F. RussellPaper - 1/7  
See serial citation

\*Fuel systems, \*Noise control, \*Fuel injection, \*Diesel engines, \*Engine noise, \*Fuel pumps, \*Damping, \*Noise sources, \*Resonant frequency,

The noise of diesel fuel injection equipment was compared with that of two quieter than average engines to show how the former noise might affect the overall noise from an engine. The contributions of the individual injection system components to the noise of the complete engine were assessed and the mechanisms of noise generation studied. Practical noise control measures developed for use with injector nozzles and distributor and in-line injection pumps are described.  
HS-012 750

#### ORIGIN OF LOW FREQUENCY NOISE IN MOTOR CARS

S. K. JhaT. PriedePaper - 1/8  
Sponsored by Science Res. Council, Great Britain, and Chrysler U. K. Ltd.  
See serial citation

\*Vehicle noise, \*Infrasound, \*Frequencies, \*Noise sources, \*Speed, \*Spectral analysis, \*Vibration, \*Sound intensity, \*Oscillographs, \*Resonance, \*Automobile bodies, \*Passenger compartments,

In cars of integral construction, maximum noise levels occur in the sub-audible frequency range, produced by vibratory forces

## Group 2G—Meteorological Conditions

generated by the engine and road. Noise in the audible frequency range is produced by car-structure bending and, particularly, by body-shell ring-mode vibrations. Different cars show similar noise-spectra characteristics, and the relation between vibration and radiated noise is identical; thus, average internal noise levels and vibratory exciting forces can be predicted. Up to 200 Hz, noise level is proportional to body-shell vibration velocity and, above this frequency, to vibration acceleration. Resonant conditions in the car-body cavity are considered.  
HS-012 751

## REDUCTION OF INTERIOR CAR NOISE BY CONTROL OF CAVITY RESONANCE

T. Shukua, Yoshida M. Nagai A. Watari 0 Paper - 1/9  
See serial citation

\*Vehicle noise, \*Noise control, \*Passenger compartments, \*Acoustics, \*Eigenvalues, \*Frequencies, \*Vibration, \*Sound absorbing materials, \*Resonance, \*Waves, \*Interior design, \*Sound intensity,

Cavity resonance was empirically found to emphasize noise in automobile compartments at certain frequencies. This paper theoretically verifies that this phenomenon approximately corresponds to the first two or three eigenvalues (standing wave frequencies) of an irregularly shaped two dimensional acoustic field, which is a longitudinal and vertical section of the compartment including the center line. The acoustic vectorial sensitivity of panel vibration varies according to the panel's position on the boundary at each frequency. Interior sound pressure can be estimated as a resultant vector of noise radiated from vibrations of all panels. The acousto-structural system with complex absorption coefficient at panel surface must be considered for more perfect analysis because the boundary panel is flexible and absorbs sound pressure. The vibrational characteristics of body panels are investigated from the viewpoint of the interior sound pressure levels.  
HS-012 752

## AN EXTERNAL NOISE REDUCTION EXERCISE ON A POPULAR BRITISH SPORTS CAR

M. R. Hearn R. J. Oliver Paper - 1/11  
See serial citation

\*Noise control, \*British vehicles, \*High powered automobiles, \*Engine noise, \*Exhaust noise, \*Exhaust systems, \*Air filters, \*Sound intensity, \*Spectral analysis, \*Fuel consumption, \*Sound absorbing materials, \*Fans, \*Performance tests, \*Noise standards, \*Power loss, \*Acceleration, \*Reverberation,

In the first stage of the development program noise level was reduced to 84dB (A) to meet the 1968 British regulation. Tests were performed on the engine air-intake and a cheap and practical noise-reducing system was developed. In the second stage, noise level was reduced to 80 dB (A) and below. Such reduction can be achieved by using sound-absorbing material and an electric fan, but the best results were produced by a special type of exhaust system. Power losses were low and interior noise levels comparable with the current exhaust system. Efforts to reduce radiated engine noise had little effect.  
HS-012 753

## THE EXPERIMENTAL STUDY OF TRUCK TIRE NOISE

For primary bibliographic entry see Fld. 5V.  
HS-012 754

## METHODE DE CALCUL POUR LES BRUITS BASSE FREQUENCE DANS UN HABITACLE DE VOITURE (METHOD OF CALCULATION OF LOW-FREQUENCY NOISE IN A VEHICLE PASSENGER COMPARTMENT)

R. Le Salver G. Jennequin Paper - 1/13  
Text in French.  
See serial citation

\*Infrasound, \*Passenger compartments, \*Mathematical models, \*Noise control, \*Noise sources, \*Vibration, \*Damping, \*Vehicle noise,

A mathematical model of the acoustic behavior of the inner volume of a vehicle passenger compartment is used to determine the noise field. Vibration of the panels is discussed and the intrinsic properties of the cavity considered by dividing the volume of air in the compartment into individual cubes. The mathematical model calculates the excitation of each of the acoustic modes resulting from the vibration of each panel and, with acoustic damping provided for each mode, the noise observed at any given point. A chart of the effect of vibration on noise permits prediction of the points where modification of the panels is necessary for effective noise reduction.  
HS-012 755

## MESURE DU BRUIT DES AUTOMOBILES (THE MEASUREMENT OF VEHICLE NOISE)

J. P. Thiry Paper - 1/14  
Text in French.  
See serial citation

\*Vehicle noise, \*Acoustic measurement, \*Sound intensity, \*Passenger compartments, \*Test volunteers, \*Noise tolerances, \*Spectral analysis, \*Design of experiments,

Sensitivity of subjects to differences in vehicle interior noise level is tested, to determine the smallest noise level intensity variation perceptible to the majority of subjects. The discomfort created as a function of spectral noise composition and the correction of noise-duration are also tested in order to arrive at some quantity tending to modify noise measurements as a function of the duration of the noise and the gradient of the level, thus allowing the integration of these factors into the expression for discomfort. Test procedures and difficulties encountered are outlined. It is imperative that noise measurements should provide, for set points in the vehicle interior, a statistical distribution with time of the overall noise and the noise in octave bands. A vehicle-operating cycle similar to those for exhaust emission work is proposed for the noise measurement.  
HS-012 756

## VEHICLE DESIGN AND DEVELOPMENT TRENDS FOR LOW NOISE EMISSION

For primary bibliographic entry see Fld. 5D.  
HS-012 757

### 3. HUMAN FACTORS

#### WHAT ARE MACHINES DOING TO WOMEN?

Oakland Univ., Mich.  
L. A. Middendorf/SAE-730019  
Presented at International Automotive Engineering Congress,  
Detroit, 8-12 Jan 1973.  
SAE

\*Human factors engineering, \*Automobile usage, \*Females,  
\*Age factors, \*Marital status, \*Consumer attitudes, \*man  
machine systems, \*Opinion polls, \*Chi square test,

Since human factors engineering has focused largely on the male operator in the man-machine system, information concerned with female-machine relationships is derived mainly from studies of males. Studies of women at work and a survey of 43 adult females ranging in age from 20-81 years indicate that machines females associate with everyday both facilitate and complicate their lives. Females responded to a significant degree in a highly positive manner to most of their modern conveniences. In terms of measured positive responses, the automobile obtained the most positive response pattern. Female study participants requested machines that were simpler to operate. Human factors engineering should address itself more to the distinctive problems of the female operator in the human-machine system.  
HS-012 724

#### 3B. Anthropomorphic Data

BASIC RESEARCH IN CRASHWORTHINESS 2-  
DEVELOPMENT OF MOVING BARRIER TEST  
TECHNIQUE. INTERIM TECHNICAL REPORT  
Calspan Corp.  
For primary bibliographic entry see Fld. 5D.  
HS-800 799

#### 3D. Driver Behavior

##### SOME FACTORS LIMITING DRIVER-VEHICLE PERFORMANCE

Michigan Univ. Hwy. Safety Res. Inst.  
R. G. Mortimer/P. L. Olson/SAE-730017  
Presented at International Automotive Engineering Congress,  
Detroit, 8-12 Jan 1973.  
SAE

\*Driver performance, \*Vehicle control, \*Driver tests, \*Performance tests, \*Steering, \*Braking forces, \*Driver experience, \*Road curves, \*Turning radius, \*Wet road conditions, \*Dry road conditions, \*Antiskid brakes, \*Vehicle handling, \*Spectral analysis, \*Lateral acceleration, \*Lane changing, \*Accident avoidance, \*Driver skills, \*Driving task analysis, \*Coefficient of friction, \*Pavement friction, \*Gap acceptance, \*Car following, \*Tracking, \*Oversteer, \*Deceleration, \*Yaw,

Measurement of drivers' performance at the limit of capability is difficult due to methodological problems, moment to moment variability of drivers, differences between drivers, and their interactions with the characteristics of the vehicle, road, and environment. Longitudinal and lateral vehicle control are

discussed by reference to results of braking and steering tests, with emphasis on variations between performance of drivers. Driver effectiveness in vehicle braking is a function of the brake system deceleration/pedal force gain. Overall braking performance could be improved by increasing the abilities of drivers who are poor in this task by training in brake modulation on dry and wet pavements. The best drivers are as effective as an antilocking brake system, except on the equivalent of ice covered pavement. In steering control drivers increase their response frequency bandwidth as task difficulty increases. Comparisons are shown between an inexperienced and an experienced driver in curve negotiation.  
HS-012 722

#### MEASURING CAR-DRIVER INTERACTION WITH THE g-g DIAGRAM

Calspan Corp.  
R. S. Rice/SAE-730018  
Presented at International Automotive Engineering Congress,  
Detroit, 8-12 Jan 1973. willingness limits, driver idiosyncracies, and task descriptions. Drivers usually employ healthy margins of performance on dry roads and normal modes of operation are predominantly along the axes (pure cornering, pure braking, and pure driving). Applications of the method to handling  
SAE

\*Automobile performance, \*Driver performance, \*Automobile handling, \*Driving task analysis, \*Vehicle control, \*Tire pavement interface, \*Coefficient of friction, \*Confidence intervals, \*Driver skills, \*Performance tests, \*Cornering, \*Turning radius, \*Braking forces, \*Wet road conditions, \*Dry road conditions, \*Road tests, \*Proving ground tests,

Based on a continuous plot of the vector acceleration of the vehicle in the horizontal plane, the resultant figure, a g-g diagram, is shown to be useful for characterizing the vehicles' envelope of performance, variation of this envelope with tire-road surface conditions, accessibility of various operating points to the driver in task performance, performance margins utilized by the driver in normal operation, and for other applications. Proving ground and road test results are analyzed in terms of driver willingness limits, driver idiosyncracies, and task descriptions. Drivers usually employ healthy margins of performance on dry roads and normal modes of operation are predominantly along the axes (pure cornering, pure braking, and pure driving). Applications of the method to handling studies, driver training, and general vehicle research and development are described.  
HS-012 723

#### DECISION MAKING IN DYNAMIC CIRCUMSTANCES

Oakland Univ., Mich.  
J. Dumas/SAE-730022  
Presented at International Automotive Engineering Congress,  
Detroit, 8-12 Jan 1973.  
SAE

\*Driving task analysis, \*Driver experience, \*Memory, \*Driver performance, \*Driver fatigue, \*Attention lapses, \*Information systems, \*Decision making, \*Driver behavior,

The research on cognitive processes can be usefully organized by considering the human decision maker to be a type of complex information handling system. By examining the characteristics of this system and comparing it with other information

handling systems, we gain some insight into its assets and limitations. The nature of these limitations have important implications for how the human information processor functions while driving an automobile. Experience, alertness, and familiarity were found to be necessary for the efficient functioning of this system in a driving environment.  
HS-012 725

### 3K. Pedestrians

#### STATISTICAL ANALYSIS OF CHILD PEDESTRIAN ACCIDENTS IN MANCHESTER AND SALFORD

V4 N4

B. Preston

See serial citation

\*Vehicle pedestrian collisions, \*Child safety, \*Accident analysis, \*Accident statistics, \*Manchester (England), \*Salford, \*Pedestrian injuries, \*Child injuries, \*Injuries by age, \*Injuries by sex, \*Accident causes, \*Accident location, \*Residential streets, \*Accident rates, \*Social class, \*Injury rates, \*Traffic density, \*Population density, \*Playgrounds, \*Safety zones, \*Accident prevention, \*Statistical analysis,

The age and sex of 980 children injured in 1969, where the accident happened, and, when available, what the children were doing, are presented. The accident rate for children aged 3-7 differed considerably in different areas from more than 2 per 100 children of that age in the worst area, to less than 2 per 1,000 in the best area. There was a statistically significant correlation between measures of overcrowding or of social class and the accident rate for boys of this age but not for girls. There was no difference in the distance from home, or the type of road on which the boys and girls were injured, but young boys were more likely to be injured while playing than girls. It is suggested that the provision of safe play spaces could reduce the accident rate for young boys in the worst accident areas.  
HS-012 680

### 3L. Vision

#### THE EFFECT OF LIGHT ABSORBING MEDIA ON DRIVER VISUAL PERFORMANCE. FINAL REPORT

Brown Engineering Co., Inc.

A. R. Dunn

Contract DOT-HS-089-2-453

Report for Jul 1972-Jan 1973.

NTIS

\*Night visibility, \*Optical filters, \*Visual degradation, \*Windshields, \*Tinted glass, \*Driver performance, \*Performance tests, \*Vision tests, \*Light conditions, \*Reduced visibility, \*Light transmission, \*Eye injuries, \*Night vision, \*Sight distances,

Analytical and experimental determinations were made of the effects of windshields and filters on probability of detecting objects and on seeing distances after dark. The analytical study showed that visual degradation increases more rapidly for filter transmittances less than 79%. The experimental study showed that seeing distances through clear windshields are greater than those through tinted windshields; the difference is less than 15 feet. The seeing distances attained by individual observers ranged from 200 to 600 feet. Eye damage can be sustained

through all types of automobile glass studied. In particular, the shaded bands at the tops of windshields may increase the probability that a driver will sustain a retinal burn. Recommendations for automobile glass transmittances were made from the results of the analyses.  
HS-800 815

### 4. OTHER SAFETY-RELATED AREAS

#### 4G. Mathematical Sciences

##### ALTERING HYDRODYNAMIC TORQUE CONVERTER PERFORMANCE

Clarke Equipment Co.

For primary bibliographic entry see Fld. 5D.

HS-012 708

##### DESIGN EQUATIONS FOR A SPEED AND TORQUE CONTROLLED VARIABLE RATIO V-BELT TRANSMISSION

Dayco Corp.

For primary bibliographic entry see Fld. 5D.

HS-012 710

##### HEADLAMP AIM CORRECTING DEVICES

Lucas (Joseph) (Electrical) Co. Ltd. (England)

For primary bibliographic entry see Fld. 5J.

HS-012 718

##### ROAD RATING TRENDS OF UNITED STATES MOTOR CARS--A REVIEW OF RECENT CRC PROGRAMS

Texaco, Inc.

For primary bibliographic entry see Fld. 5F.

HS-012 719

##### TRANSIENT OVERVOLTAGES IN ALTERNATOR SYSTEMS

Lucas (Joseph) (Electrical) Co. Ltd. (England)

For primary bibliographic entry see Fld. 5D.

HS-012 735

##### A MECHANISM OF DISC BRAKE SQUEAL

For primary bibliographic entry see Fld. 5A.

HS-012 745

##### COMMERCIAL VEHICLE EXTERIOR NOISE

For primary bibliographic entry see Fld. 2G.

HS-012 747

##### SUSPENSION DESIGN TO REDUCE INTERNAL ROAD NOISE

For primary bibliographic entry see Fld. 5R.

HS-012 748

##### PISTON MOVEMENT AS A SOURCE OF ENGINE NOISE

For primary bibliographic entry see Fld. 2G.

HS-012 749

**ORIGIN OF LOW FREQUENCY NOISE IN MOTOR CARS**

For primary bibliographic entry see Fld. 2G.  
HS-012 751

**AN EXTERNAL NOISE REDUCTION EXERCISE ON A POPULAR BRITISH SPORTS CAR**

For primary bibliographic entry see Fld. 2G.  
HS-012 753

**METHODE DE CALCUL POUR LES BRUITS BASSE FREQUENCE DANS UN HABITACLE DE VOITURE (METHOD OF CALCULATION OF LOW-FREQUENCY NOISE IN A VEHICLE PASSENGER COMPARTMENT)**

For primary bibliographic entry see Fld. 2G.  
HS-012 755

**RUSSBILDUNG IN OTTO-MOTOREN (SOOT-FORMATION IN SPARK-IGNITION ENGINES)**

For primary bibliographic entry see Fld. 5F.  
HS-012 759

**EXPERIMENTAL ANALYSIS ABOUT THE EFFECT OF ENGINE DESIGN FACTORS ON EXHAUST EMISSIONS**

For primary bibliographic entry see Fld. 5F.  
HS-012 762

**MOGLICHKEITEN ZUR VERMINDERUNG DER STICKOXYDBILDUNG IN OTTO-MOTOREN INSBESONDERE DURCH SCHICHT-LADUNGSBETRIEB UND KATALYTISCHE KONVERTIERUNG (POSSIBILITIES OF REDUCING NITROGEN-OXIDE FORMATION IN SPARK-IGNITION ENGINES, ESPECIALLY BY STRATIFIED-CHARGE OPERATION AND CATALYTIC CONVERSION)**

For primary bibliographic entry see Fld. 5F.  
HS-012 764

**DIE-STICKOXIDBILDUNG IM OTTO-MOTOR (NITROGEN-OXIDE FORMATION IN SPARK-IGNITION ENGINES)**

For primary bibliographic entry see Fld. 5F.  
HS-012 766

**TEST AND EVALUATION OF THE AMF INC. AND FAIRCHILD INDUSTRIES EXPERIMENTAL SAFETY VEHICLES, VOL. 4. ESV PROGRAM SUMMARY. FINAL REPORT**

Dynamic Science  
For primary bibliographic entry see Fld. 5D.  
HS-800 786

**5. VEHICLE SAFETY**

**5A. Brake Systems**

**A MECHANISM OF DISC BRAKE SQUEAL**

M. R. NorthPaper-1/2  
See serial citation

\*Disc brakes, \*Mathematical models, \*Brake noise, \*Vibration, \*Brake discs, \*Frequencies, \*Oscillation, \*Equations of motion, \*Degrees of freedom, \*Stiffness, \*Damping, \*Inertial forces, \*Brake friction,

An investigation into the frictionally induced, self-excited vibrations which occur in braking systems, generally known as squeal, is described. A lumped parameter, linear, eight degree of freedom system is proposed to describe the vibrational behavior of a typical disc brake system and it is shown that, under certain conditions, an oscillatory instability can occur. The importance of stiffness nonlinearity in assessing the areas of instability is shown and the presence of limit cycles explained. Parameter values are inserted in the equations and the correlation between theory and practice examined. It is concluded that the degree of correlation for the case considered, together with the qualitative explanations that the theory can give to a number of experimental observations, gives the proposed theoretical model a firm foundation.

HS-012 745

**5D. Design**

**ALTERING HYDRODYNAMIC TORQUE CONVERTER PERFORMANCE**

Clarke Equipment Co.  
M. J. WacławekSAE-730001  
Presented at International Automotive Engineering Congress, Detroit, 8-12 Jan 1973.  
SAE

\*Torque converters, \*Hydrodynamics, \*Driver gears, \*Turbines, \*Mathematical analysis, \*Performance characteristics, \*Differentials, \*Fluid drives, \*Regeneration, \*Equations,

The different types of polyphase, multistage, and floating element hydrodynamic torque converters and their variations are given. Also described are all possible methods of combining torque converters with gearing to alter their performance. The gear systems reviewed are: differentially geared, differential reactors, conventionally geared, and auxiliary element geared. These systems are also investigated in both input and output coupled arrangements. Also shown is a parametric method of representing torque converter performance when more than two elements are permitted to rotate. Equations are disclosed which permit performance calculations for all types of geared element torque converters and combinations.

HS-012 708

**PERFORMANCE EFFECTS OF VEHICLE VARIABLES**

Borg-Warner Corp.  
W. FisherSAE-730002  
Presented at International Automotive Engineering Congress, Detroit, 8-12 Jan 1973.  
SAE



**Field 5—VEHICLE SAFETY****Group 5D—Design**

\*Vehicle performance, \*Performance characteristics, \*Acceleration, \*Vehicle design, \*Transmission design, \*Torque converters, \*Engine size, \*Torque, \*Vehicle weight, \*Equations, \*Steady state, \*Mathematical analysis, \*Variables, \*Road grades,

The separate effects of important variables in vehicle and transmission design are evaluated as they relate to performance, and are given in terms of vehicle speed and wheel torque. The significance of the variables is shown in steady-state gradeability and acceleration performance curves, with speed versus wheel torque plotted on logarithmic scales. The effects of vehicle variables as deduced from this analysis may be used as a basis for predicting performance of various vehicle and transmission designs.

HS-012 709

### **DESIGN EQUATIONS FOR A SPEED AND TORQUE CONTROLLED VARIABLE RATIO V-BELT TRANSMISSION**

Dayco Corp.

L. R. Oliver K. G. Hornung J. E. Swenson H. N. Shapiro SAE-730003

Presented at International Automotive Engineering Congress, Detroit, 8-12 Jan 1973.

SAE

\*Transmission design, \*Drive systems, \*Torque, \*Belts, \*Mathematical analysis, \*Tension (mechanics), \*Coefficient of friction, \*Springs, \*Sheaves, \*Camshafts, \*Test equipment, \*Equations,

A type of V-belt drive which shifts ratios in accordance with input speed and output torque has been successfully employed as the transmission for vehicles ranging from snow mobiles to compact automobiles. This paper presents a derivation of design equations for a symmetrical V-belt drive in which centrifugal control is governed by an expanding garter spring and torque control results from a helical cam. Experimental results are included which support the validity of these equations.

HS-012 710

### **URETHANE ENERGY ABSORBERS FOR AUTOMOBILE BUMPER**

Davidson Rubber Co.

P. A. Weller SAE-730025

Presented at International Automotive Engineering Congress, Detroit, 8-12 Jan 1973.

SAE

\*Energy absorption, \*Energy absorbing bumpers, \*Urethane bumpers, \*Plastic foams, \*viscoelasticity, \*Hysteresis, \*Equations, \*Static tests, \*Dynamic tests, \*Density, \*Temperature, \*Stress strain characteristics,

Concepts and data for the design and application of microcellular urethane foam for absorbing energy in automobile bumpers are presented. Of particular significance is the demonstration of temperature compensation that overcomes the significant variation in modulus with change in temperature that is characteristic of urethane. It is shown that by appropriate design techniques, peak force can be maintained constant even with variations in modulus as high as 6:1. Packaged absorbers, free energy blocks, and urethane faced bumpers are discussed.

HS-012 726

### **AN ENERGY ABSORBING ELASTOMERIC BUMPER**

Ford Motor Co.

H. Hintzen R. A. Dunleavy SAE-730027

Presented at International Automotive Engineering Congress, Detroit, 8-12 Jan 1973.

SAE

\*Urethane bumpers, \*Energy absorbing bumpers, \*Elastomers, \*Bumper design, \*Bumper standards, \*Urethanes, \*Low speed impact tests, \*Barrier collision tests, \*Barrier impact force, \*Pendulum tests, \*Impact velocity, \*Bumper height, \*Displacement, \*Deflection,

Microcellular urethane, as facing for a fixed bumper, was established as functional material for reducing impact forces in low speed vehicle collisions. The sharply increased modulus at low temperature typical of many urethane elastomers, a cause of high forces upon impact, was overcome in compounds developed during this project. An energy absorbing bumper with high aesthetic appeal is described, which is capable of meeting pendulum impact standards. Testing procedures and data reduction systems were developed to provide access to a large volume of test data.

HS-012 727

### **PAINTED AND COLOR-PIGMENTED ELASTOMERICS FOR BUMPER STONE DEFLECTORS**

Ford Motor Co.

G. M. Wolf E. P. DePalma SAE-730028

Presented at International Automotive Engineering Congress, Detroit, 8-12 Jan 1973.

SAE

\*Elastomers, \*Elastomer specifications, \*Automobile materials, \*Paints, \*Energy absorbing bumpers, \*Urethane, \*Vinyl resins, \*Physical properties, \*Durability tests, \*Adhesives, \*Stone deflectors, \*Ethylene propylene terpolymer,

Painted and color-pigmented elastomerics, specifically painted microcellular urethane and ethylene propylene terpolymer (EPDM), and painted and color-pigmented vinyls are being employed extensively as highly flexible bumper stone deflectors on 1973 passenger vehicles built in the United States. The urethane parts are fabricated by a cast process; the EPDM is extruded, compression and injection molded; and the vinyls are extruded or injection molded. The urethanes and some vinyls are painted by conventional paint processes, whereas the EPDM is treated by a specific surface activation prior to painting. A wide range of colors, including metallics, are used to match the painted body to provide color continuity. On some vehicles black, argents, and grey colors are employed where the stone deflector is not as highly visible or where a pleasing color contrast is desired.

HS-012 728

### **BUMPER DESIGN, MATERIALS, AND FABRICATION**

North American Rockwell Corp.

R. R. Golze R. F. Kienle SAE-730030

Presented at International Automotive Engineering Congress, Detroit, 8-12 Jan 1973.

SAE

\*Bumper design, \*Bumper standards, \*Low speed impact tests, \*Barrier collision tests, \*Pendulum tests, \*Beams, \*Materials tests, \*Yield strength, \*Steels, \*Strain (mechanics), \*Bars, \*Bolts, \*welding, \*Bonding, \*Stiffness, \*Performance tests,

Development of a lightweight, low-cost bumper that is compatible with styling and durable enough to suffer little or no damage during impact at 5 mph (8km/h) is described. Boxlike sections, utilizing the face bar as an integral stressed member and judiciously employing beads and gussets, give best strength and stiffness. Materials should be of highest yield strength compatible with formability, and welded or bonded fabrication, approaching one-piece box construction, results in optimum structural properties.

HS-012 729

### THE 1973 GENERAL MOTORS HYDRAULIC-PNEUMATIC ENERGY ABSORBER BUMPER SYSTEM

General Motors Corp.

K. H. Carpenter L. L. Kerr SAE-730031

Presented at International Automotive Engineering Congress, Detroit, 8-12 Jan 1973.

SAE

\*Hydraulic bumpers, \*Pneumatic bumpers, \*Energy absorption, \*Bumper design, \*Corrosion tests, \*Cold weather tests, \*Fatigue tests, \*Energy absorbing bumpers,

Energy absorber designs may store or dissipate energy. Storing implies a subsequent return of the impact energy in a rebound reaction. Dissipation can be either destructive--metal flow--or nondestructive--shearing of a working fluid. Automotive bumper systems are of maximum value from a performance and aesthetic standpoint only when at the design position, implying self-restoration after impact. Features of the General Motors energy absorber that dissipates impact energy and also self-restores are presented and the testing used to qualify the design for customer usage and compliance with federal standards on bumper systems is discussed.

HS-012 730

### THE 1973 FORD IMPACT ABSORBING BUMPER SYSTEM

Ford Motor Co.

J. M. Slessor K. C. Rusch R. A. Pett SAE-730032

Presented at International Automotive Engineering Congress, Detroit, 8-12 Jan 1973.

SAE

\*Energy absorbing bumpers, \*Bumper standards, \*Bumper design, \*Ford Motor Co., \*Rubber, \*Elastomer specifications, \*Shear stress, \*Strain (mechanics), \*Beams, \*Bonding, \*Temperature endurance tests, \*Fatigue (materials), \*Adhesives, \*Stamping, \*Manufacturing, \*Loading (mechanical), \*Strength (mechanics), \*Corrosion resistance, \*Crashworthiness,

The Federal government requires that all 1973 passenger cars be capable of withstanding a 5 mph front bumper and a 2.5 mph rear bumper fixed-barrier impact without damage to safety related components (lighting, latching, fuel, exhaust, cooling, propulsion, steering, and braking systems). Impact energy can be handled by a thick, flexible, external covering or large, flexible bumper guards attached to a rigid bumper-bar which is

rigidly attached to the chassis by suitable supports or by a rigid reinforced bumper-bar attached to the chassis by means of compliant or compressible impact absorbing devices. Whereas, some systems utilize fluid-flow through an orifice to absorb energy, Ford Motor Company devices utilize shear deformation of rectangular rubber blocks.

HS-012 731

### 1974 VW ENERGY-ABSORBING BUMPER SYSTEM

HS-012 732

### PUMP DEVELOPMENT--SELECTION OF DESIGN CONCEPTS BY ANALYSIS

Sperry Rand G. m. b. H. (West Germany)

O. Langosch SAE-730042

Presented at International Automotive Engineering Congress, Detroit, 8-12 Jan 1973.

SAE

\*Pumps, \*Hydraulic equipment, \*Hydraulic design factors, \*Performance characteristics, \*Oil pumps, \*Weight to power ratio, \*Gear teeth, \*Pistons, \*Displacement, \*Operating pressure, \*Economic factors, \*Vehicle noise,

The analysis of the basic hydraulic pump designs allows a comparison of their strengths and weaknesses. Some judgement criteria are presented to assist in selection of such design principles which offer acceptable compromises with a minimum number of different designs. Capsular and piston pumps are analyzed and evaluated. Capsular pumps, including external gear pumps, internal gear pumps, and balanced vane pumps, offer advantages for fixed displacement pumps and all three design types can be used for many different applications. The piston pump concepts offer advantages compared to capsular pumps for variable displacement units. Within the group of piston pumps, the axial piston arrangement is the preferred one and the in-line concept is the most attractive for high pressure-variable displacement pumps.

HS-012 734

### TRANSIENT OVERVOLTAGES IN ALTERNATOR SYSTEMS

Lucas (Joseph) (Electrical) Co. Ltd. (England)

A. W. Winkley M. J. Allport SAE-730043

Presented at International Automotive Engineering Congress, Detroit, 8-12 Jan 1973.

SAE

\*Alternators, \*Voltage regulators, \*Electric system failure, \*Voltage, \*Batteries, \*Diodes, \*Energy absorption, \*Electric system design, \*Alternating current drive systems, \*Ignition systems, \*Mathematical analysis,

Failure of electronic equipment in the alternator system will occur only under fault conditions. Overvoltage levels generated by the alternator and external equipment are discussed. Safe operation can be ensured by high voltage rating or by absorbing energy to reduce the transient voltage. These two methods are compared and transient energy measurements described. Problems in defining a precise specification for the necessary level of protection are stated and proposals made for an acceptable specification based upon experience.

HS-012 735

## Group 5D—Design

**CONTROL OF THE AUTOMOTIVE ELECTRICAL ENVIRONMENT**

Bendix Corp.

G. B. AndrewsSAE-730045

Presented at International Automotive Engineering Congress, Detroit, 8-12 Jan 1973.

SAE

\*Electronic devices, \*Electric system failures, \*Voltage regulation, \*Alternators, \*Electric systems, \*Engine noise, \*Noise control, \*Batteries, \*Electromagnetic interference, \*Electric system design,

The automotive electrical environment is characterized by voltage fluctuations, noise, and severe transients. Mishandling and degradation of electrical components of the automotive power supply exaggerate these conditions. Electromagnetic interference arises from energy radiated from sources within and outside the vehicle. Measurements of these types of electrical disturbances on contemporary automobiles and their effect on the performance of electronic equipment are discussed. Causes for temporary and permanent degradation of electronic equipment are investigated, and a systems approach to the problem is recommended. Improvements to the electrical environment should be directed to the source of disturbances, as opposed to dealing with the disturbances at the interface between the power supply and each electronic package.

HS-012 736

**AIR-COOLED ROTARY ENGINES--A FUELS AND LUBRICANTS STUDY**

Army Fuels and Lubricants Res. Lab.

J. A. RussellS. J. LestzJ. T. GraySAE-730046

Presented at International Automotive Engineering Congress, Detroit, 8-12 Jan 1973.

SAE

\*Lubricating oils, \*Leaded gasoline, \*Lead free gasoline, \*Lubricating oil tests, \*Rotary engines, \*Performance tests, \*Durability tests, \*Fuel composition, \*Physical properties, \*Chemical properties, \*Sulfur, \*Deposition, \*Engine deposits, \*Engine tests, \*Engine performance, \*Engine wear, \*Seals, \*Exhaust emissions, \*Power loss, \*Air cooled engines,

Several MIL-L-2104C lubricants were evaluated in a small air-cooled rotary combustion engine, using leaded and unleaded gasoline. A 50 h endurance test was developed which discriminates lubricant quality on the basis of combustion chamber, spark plug, and side plate deposits. Additionally, use of unleaded fuel resulted in an eventual decrease in engine performance at approximately the 40 h mark. This is attributed to the character of apex and side seal groove deposits which caused seal spring binding and consequent blow-by. The presence of sulfur in each fuel may also have an attenuative effect on such binding.

HS-012 737

**LUBRICATION OF THE WANKEL ROTARY ENGINE**

Labofina S.A. (Belgium)

G. J. SouillardF. F. Van QuaethovenSAE-730047

Presented at International Automotive Engineering Congress, Detroit, 8-12 Jan 1973.

SAE

\*Wankel engines, \*Lubrication, \*Lubricating oils, \*Oil tests, \*Durability tests, \*Engine tests, \*Apex seal deposits, \*Engine wear, \*Performance tests, \*Preignition,

The unique design of the Wankel rotary engine creates special problems in lubrication. To lubricate the Wankel engine, one part of the oil is injected in the air fuel mixture to lubricate the wall of the epitrochoid surface and another part is circulated on the shaft bearings and to cool the rotor. In both cases, problems to solve are the lubricant is necessarily a compromise to meet different requirements. At this stage, the best lubricant is a synthetic mineral oil blend with an appropriate combination of additives. The synthetic oil is a petrochemical product of polymerization of a monoolefin. With such a lubrication, deposits in the combustion chamber are reduced to a minimum, avoiding preignition and seal sticking. Seal wear has been reduced and engine life is longer. The performance of such a formulation has been tested in water-cooled engines.

HS-012 738

**LUBRICANT AND FUEL REQUIREMENTS AND GENERAL PERFORMANCE DATA OF WANKEL ROTARY PISTON ENGINES**

BP Benzin und Petroleum A.G. (West Germany)

For primary bibliographic entry see Fld. 5F.

HS-012 739

**ELASTOHYDRODYNAMIC SEALING SYSTEMS**

General Motors Corp.

J. D. SymonsSAE-730049

Presented at International Automotive Engineering Congress, Detroit, 8-12 Jan 1973.

SAE

\*Elastohydrodynamics, \*Seals, \*Shafts, \*Life tests, \*Performance tests,

The differences between standard sealing systems and elastohydrodynamic sealing systems are discussed, and a comparison of the two systems is prepared by a subcommittee of the SAE Transm. Drivetrain Committee on elastohydrodynamic sealing systems. A review of elastohydrodynamic sealing systems is reviewed. An elastohydrodynamic sealing system with a supplemental sealing device either on the seal itself or on the shaft. Unirotational and birotational seals for both shafts are described. Methods used in evaluating elastohydrodynamic seals are discussed and evaluated. It is concluded that visual examination of the seal on a plane, roll-coined spiral-grooved mandrel testing, and oil drop tests are the best methods for evaluating elastohydrodynamic sealing systems.

HS-012 740

**REDUCING OPERATING TEMPERATURES OF ELASTOMERIC SEALING LIPS**

Chicago Rawhide Mfg. Co.

L. A. HorveSAE-730050

Presented at International Automotive Engineering Congress, Detroit, 8-12 Jan 1973.

SAE

\*Oil seals, \*Heat transfer, \*Temperature, \*Shafts, \*Elastohydrodynamics, \*Waves, \*Life tests, \*Performance characteristics, \*Seal design,

The life of an elastomeric seal is highly dependent upon the temperature between the lip and the shaft. High temperatures will promote early failure if the limits of the material and/or sealing fluid are exceeded. A seal design with a sinuous or wave-like contact path on the shaft will substantially lower the interface temperature, thus promoting long life. In addition, the sinuous pattern provides a positive pumping action which improves seal reliability. The selection of wave parameters to give low interface temperature with sufficient pumping ability to offset seal and shaft defects is discussed. Experimental data show the effect of seal design and wave parameters upon performance.

HS-012 741

### **CORRELATION OF PHYSICAL PROPERTIES WITH PERFORMANCE OF POLYACRYLATE RADIAL LIP SEALS AT-30F**

General Motors Corp.

J. M. Brown R. C. Drutowski SAE-730051

Presented at International Automotive Engineering Congress, Detroit, 8-12 Jan 1973.  
SAE

\*Oil seals, \*Polymers, \*Temperature endurance tests, \*Low temperature, \*Performance tests, \*Materials tests, \*Test equipment, \*Torque, \*Rubber, \*Stiffness, \*Carbon black, \*Histograms, \*Coldstarts, \*Tensile strength, \*Flexibility, \*Graphite, \*Wear tests, \*Aging, \*Cracking, \*Degradation failures,

The tendency of lip seals to fracture in a test apparatus in which dynamic runout is 0.010 inches and the temperature is cycled between -30 deg. and 0 deg. F is evaluated. Seals made of eight different polyacrylate polymers were soap-sulfer cured with various types and amounts of carbon black. Physical tests included room-temperature flexibility defined by Young's modulus at small strains, standard tensile tests at room temperature, flexibility at sub-zero temperatures determined by a Gehman test, and sub-zero starting torques of the seals. Primary determinant of successful fracture resistance is a low starting torque resulting from good low-temperature flexibility. The effect of adding graphite to some of these formulations is described and some current commercially available seals are evaluated.

HS-012 742

### **INTERNATIONAL AUTOMOBILE TECHNICAL CONGRESS OF FIATA (14TH) 25-30 JUNE 1972, LONDON**

Institution of Mechanical Engineers (England)

For primary bibliographic entry see Fld. 5F.

HS-012 743

### **THE MANY ASPECTS OF DIESEL ENGINE NOISE**

For primary bibliographic entry see Fld. 2G.

HS-012 744

### **CLUTCH JUDDER**

T. P. Newcombe R. T. Spurr Paper-1/3

See serial citation

\*Clutches, \*Vibration, \*Vibration analysis, \*Clutch facings, \*Resonance, \*Coefficient of friction, \*Test equipment, \*Resonance frequency, \*Oscillation, \*Torque,

Clutch judder has generally been attributed to a particular type of variation of the coefficient of friction of the clutch facing with velocity, but recent work has shown that this is not a necessary condition for judder to occur. An investigation showing that judder is a mechanical resonance phenomenon caused by cyclic variations in the load on the clutch, and the conditions under which it occurs are described. The practical implications of this work are discussed with particular emphasis on how to reduce the tendency of a clutch to judder.

HS-012 746

### **PISTON MOVEMENT AS A SOURCE OF ENGINE NOISE**

For primary bibliographic entry see Fld. 2G.

HS-012 749

### **ORIGIN OF LOW FREQUENCY NOISE IN MOTOR CARS**

For primary bibliographic entry see Fld. 2G.

HS-012 751

### **AN EXTERNAL NOISE REDUCTION EXERCISE ON A POPULAR BRITISH SPORTS CAR**

For primary bibliographic entry see Fld. 2G.

HS-012 753

### **METHODE DE CALCUL POUR LES BRUITS BASSE FREQUENCE DANS UN HABITACLE DE VOITURE (METHOD OF CALCULATION OF LOW-FREQUENCY NOISE IN A VEHICLE PASSENGER COMPARTMENT)**

For primary bibliographic entry see Fld. 2G.

HS-012 755

### **VEHICLE DESIGN AND DEVELOPMENT TRENDS FOR LOW NOISE EMISSION**

D. Anderton R. J. Pryce R. J. Varley Paper - 1/15

See serial citation

\*Vehicle noise, \*Noise control, \*Acoustic measurement, \*Engine noise, \*Exhaust noise, \*Fan noise, \*Sound intensity, \*Engine design, \*Commercial vehicles, \*Diesel engines, \*Compression ratio, \*Combustion, \*Turbocharging, \*Air intake noise,

Noise balance of a typical commercial vehicle is analyzed and the major vehicle noise sources are considered individually. Tests show that inlet, exhaust, and fan noise can be reduced relatively easily, but the predominating engine noise, that generated by combustion, can be controlled, in the short term, only by engine-enclosure and shielding techniques and, in the long term, by major redesign of the engine structure and tailoring of the combustion process.

HS-012 757

### **TECHNIQUES FOR REDUCING EXHAUST EMISSIONS FROM DIESEL ENGINES**

For primary bibliographic entry see Fld. 5F.

HS-012 758

**Group 5D—Design****A VARIABLE LIFT AND EVENT CONTROL DEVICE FOR PISTON ENGINE VALVE OPERATION**

Paper - 2/10

See serial citation

\*Hydraulic valve lifters, \*Valve timing, \*Reciprocating engines, \*Intake valves, \*Exhaust valves, \*Engine modification, \*Exhaust emission control, \*Cams, \*Rocker arms, \*Oscillation, \*Engine operating conditions, \*Performance characteristics,

A new system for automatically controlling valve lift and timing in reciprocating internal combustion engines was developed. Valve lifting is achieved by a rocking cam, whose profile includes a base circle and a working flank, which actuates a rocker arm controlling the valve. Timing changes are obtained by displacing some elements of this kinematic chain in such a way as to vary the active portion of the cam flank used, but without altering operating clearance. The interest in such a system stems from the possibility that it may reduce undesirable exhaust constituents. Experimental results obtained on an engine fitted with a valve event and lift control mechanism of this type indicate that, for best torque over range of operating speeds, considerable variation of valve-lift and timing is necessary. Optimum performance corresponds to minimum differences in lift and timing between intake and exhaust valves. HS-012 767

**ELECTRONIC INSTRUMENTATION SYSTEMS IN THE ENGINE LABORATORY**

T. J. BleeJ. NoddingsPaper - 2/11

See serial citation

\*Electronic devices, \*Electronic monitoring systems, \*Test equipment, \*Telemetry, \*Measuring instruments, \*Thermistors, \*Laboratory tests, \*Engine tests, \*Couplers, \*Temperature, \*Torsional vibration, \*Vibration analysis, \*Transducers,

Modern electronic systems are proving a vital factor in obtaining better utilization of engine development resources. Experimental data for research programs hitherto difficult or impossible to obtain and the monitoring and protection of engines under test are two areas where the following four systems are being successfully applied: miniature radio telemetry, inductively coupled temperature measurement, torsional vibration measurement and protection, and engine test supervision. In each case the equipment and operational specifications are presented together with a summary of user experience gained in the engine laboratory. HS-012 768

**TEST AND EVALUATION OF THE AMF INC. AND FAIRCHILD INDUSTRIES EXPERIMENTAL SAFETY VEHICLES. VOL. 1. ESV PROGRAM SUMMARY. FINAL REPORT**

Dynamic Science

2310-72-23-Vol-1

Contract DOT-OS-10187

Report for Jul 1971-Aug 1972. Vol. 2 is HS-800 784.

NTIS

For abstract and search terms, see HS-800 784--HS-800 786. HS-800 783

**TEST AND EVALUATION OF THE AMF INC. AND FAIRCHILD INDUSTRIES EXPERIMENTAL SAFETY VEHICLES, VOL. 2. ESV PROGRAM SUMMARY. FINAL REPORT**

Dynamic Science

2310-72-23-Vol-2

Contract DOT-OD-10187

Report for Jul 1971-Aug 1972. Vol. 1 is HS-800 783; vol. 3 is HS-800 785.

NTIS

\*Automobile design, \*Experimental automobiles, \*Safety cars, \*Performance tests, \*Vehicle inspection, \*Vehicle safety standards, \*Automobile dimensions, \*Vehicle weight, \*Control location, \*Instrument panel lighting, \*Visibility, \*Shift lever sequence, \*Ignition locks, \*Hydraulic brake hoses, \*Brake tests, \*Brake fluids, \*Tire tests, \*Tire sizes, \*Tire loads, \*Interior rearview mirrors, \*Mirror positioning, \*Hood latch systems, \*Vehicle identification numbers, \*Wheels, \*Hubcaps, \*Power windows, \*Data acquisition, \*Data reduction, \*Calibration, \*Test facilities, \*Test equipment,

Procedures are presented for inspection of components of two Experimental Safety Vehicles, including vehicle dimensions and weights, reach of controls and control identification and illumination, transmission shift lever sequence and braking effect, starter interlock, hydraulic brake hoses and fluid, tire size and loads, interior rearview mirror mounting, hood latch system, vehicle identification number, wheel nuts and discs, hubcaps, ignition locks, and power window systems. Procedures for consumer information and nonoperating safety evaluation of vehicle design requirements are also presented. Test instrumentation, facilities, and equipment; data acquisition and reduction systems; and calibration methods are described. Test results for each vehicle are illustrated and presented in tabular form.

HS-800 784

**TEST AND EVALUATION OF THE AMF INC. AND FAIRCHILD INDUSTRIES EXPERIMENTAL SAFETY VEHICLES, VOL. 3. ESV PROGRAM SUMMARY. FINAL REPORT**

Dynamic Science

For primary bibliographic entry see Fld. 5R.

HS-800 785

**TEST AND EVALUATION OF THE AMF INC. AND FAIRCHILD INDUSTRIES EXPERIMENTAL SAFETY VEHICLES, VOL. 4. ESV PROGRAM SUMMARY. FINAL REPORT**

Dynamic Science

2310-72-23-Vol-4

Contract DOT-OS-10187

Report for Jul 1971-Aug 1972. Vol. 3 is HS-800 785.

NTIS

\*Injury prevention, \*Experimental automobiles, \*Safety cars, \*Postcrash phase, \*Crash phase, \*Barrier collision tests, \*Materials tests, \*Flammability tests, \*Bumpers, \*Underride override collisions, \*Instrument panel impact areas, \*Pedestrian safety, \*Pole impact tests, \*Side impact tests, \*Impact velocity, \*Data acquisition, \*Data reduction, \*Test facilities, \*Impact sleds, \*Instrumented vehicles, \*Calibration, \*Anthropomorphic dummies, \*Occupant kinematics, \*Acceleration response,

\*Structural deformation analysis, \*Crush distance, \*Lateral acceleration, \*Accelerometers, \*Loading (mechanical), \*Photographs, \*Mathematical analysis, \*Test equipment,

In order to reduce accident caused injuries, tests of flat barrier and pole side impacts, bumper underride/override, interior controls and protrusions, and pedestrian safety were performed on two Experimental Safety Vehicles. Postcrash factors, including material flammability were evaluated. The method of dynamic calibration for anthropomorphic dummies used in the tests to determine occupant kinematics is presented. Instrumentation used for data acquisition, methods of data acquisition and reduction, and test facilities and equipment are described. Tests results for each vehicle are illustrated and presented graphically and in tabular form.

HS-800 786

## **BASIC RESEARCH IN CRASHWORTHINESS 2-- DEVELOPMENT OF MOVING BARRIER TEST TECHNIQUE. INTERIM TECHNICAL REPORT**

Calspan Corp.

R. A. Galganski V. F. Napierski YB-2987-V-13

Contract FH-11-7622

NTIS

\*Crashworthiness, \*Barrier collision tests, \*Side impact tests, \*Pole impact tests, \*Anthropometric dummies, \*Acceleration response, \*Head acceleration tolerances, \*Chest acceleration tolerances, \*Pelvic acceleration tolerances, \*Chevrolet, \*Seat occupation, \*Impact angle, \*Passenger compartments, \*Instrumentation, \*Accelerometers,

Results of 12 side impact tests between a rigid moving barrier and stationary standard vehicles are presented. In phase one of this task, four different cars were subjected to 90 degree impacts by a moving pole barrier. In phase two, two pair of identical vehicles were struck by a moving contoured barrier (one 45 degree impact followed by one 90 degree impact per car). The test vehicles for the second phase tests consisted of 1971 Chevrolet Vega two-door sedans and 1971 Chevrolet Impala two-door hardtops. In all tests, two instrumented unrestrained anthropometric dummies were on-board each test car, one each located in the front and rear seat adjacent to the struck side of the vehicles. For all tests, passenger compartment accelerations and head, chest, and pelvic accelerations of the dummies are presented. Occupant accelerations are compared briefly with human tolerance data. Injury criteria were met in all but one crash test.

HS-800 799

## **AUTOMOTIVE TAPE RECORDER. VOL. 5. DATA PROCESSING AND POST-CALIBRATION. FINAL REPORT**

AVCO Corp.

D. LeFevre R. D'Auteuil AVSD-0135-72-CR-Vol-

Contract FH-11-7603

Report for Feb-Nov 1972. Vol. 4 is HS-800 808.

NTIS

\*Tape recorders, \*Magnetic tapes, \*Tape recordings, \*Data processing, \*Calibration, \*Precrash phase, \*Crashphase, \*Speed, \*Braking forces, \*Pressure, \*Steering, \*Acceleration, \*Accelerometers, \*Impact velocity, \*Flow charts, \*Pressure transducers, \*Sensors,

Procedures for processing the digital data recorded on magnetic tape by the Automotive Tape Recorder are discussed in detail. The recorded data includes precrash and crash measurements of speed, brake pressure, steering wheel motion, and accelerations in three axes. The recorded data is presented in graphical form. Typical equipment for processing and displaying the data is identified. Characteristics of transducers for vehicle measurements are discussed for use in post-calibration of the measurements.

HS-800 809

## **5F. Fuel Systems**

### **SPARK IGNITION ENGINE CONTROL VARIABLE STUDY**

Bendix Corp.

T. W. Keranen H. P. Wertheimer SAE-730004

Presented at International Automotive Engineering Congress, Detroit, 8-12 Jan 1973.

SAE

\*Exhaust emission control, \*Exhaust emission tests, \*Spark ignition engines, \*Exhaust gas recirculation, \*Nitric oxide, \*Hydrocarbons, \*Carbon monoxide, \*Fuel consumption, \*Fuel ratio, \*Ignition timing, \*Fuel economy, \*Engine size, \*Effect on exhaust emissions, \*Engine tests, \*Power output, \*Exhaust emission measurement, \*Lean fuel mixtures, \*Simulation

Systematic testing of a fuel injected 429 cubic inch (7.0 liter) V-8 engine at steady states produced data from which the effects on emissions of three control variables in combination could be determined. Plotted data of specific nitric oxide, hydrocarbons, and carbon monoxide as well as brake specific fuel consumption, are presented as a function of air-fuel ratio, ignition timing, and percent exhaust gas recirculation (EGR). Analysis of trends shows that EGR permits nitric oxide control with less fuel consumption penalty than extreme rich operation alone. Nitric oxide control is shown to be important at low power levels as well as at high power levels while hydrocarbons are much more of a problem at the high power levels than at high engine outputs. An optimum air-fuel ratio for the weight of a vehicle is indicated. Simulation of engine emission tests permits comparisons between different control approaches, suggesting entirely different calibrations for different emission performance goals.

HS-012 711

### **CLOSED-LOOP ELECTRONIC FUEL INJECTION CONTROL OF THE INTERNAL-COMBUSTION ENGINE**

Bendix Corp.

J. G. Rivard SAE-730005

Presented at International Automotive Engineering Congress, Detroit, 8-12 Jan 1973.

SAE

\*Internal combustion engines, \*Electronic fuel injection, \*Injection timing, \*Oxygen detectors, \*Air fuel ratio, \*Exhaust emission control, \*Catalytic converters, \*Hydrocarbons, \*Carbon monoxide, \*Nitrogen oxides, \*Exhaust emission measurement, \*Exhaust emission sampling, \*Stoichiometry, \*Exhaust emission measurement,

**Group 5F--Fuel Systems**

A sensor has been developed that measures oxygen concentrations in the exhaust gases and outputs an electrical voltage that changes sharply as the air/fuel ratio approaches the stoichiometric point. By sensing this unique operating point and feeding back signals to the electronic control circuitry, it becomes possible to so vary the fuel distribution that the air/fuel ratio can be realistically maintained within a ratio range of plus or minus 0.1. The three-way exhaust-gas catalyst used with the closed-loop control very efficiently reduces the concentrations of hydrocarbons, carbon monoxide, and oxides of nitrogen within this limited ratio range. The system provides good vehicle driveability, performance, and fuel economy.  
HS-012 712

**NEW PISTON RING INNOVATIONS TO HELP CONTROL AUTOMOTIVE ENGINE EMISSIONS**

TRW, Inc.  
H. F. PrasseH. E. McCormickR. D. AndersonSAE-730006  
Presented at International Automotive Engineering Congress, Detroit, 8-12 Jan 1973.  
SAE

\*Piston rings, \*Exhaust emission control, \*Engine design, \*Exhaust emission standards, \*Oil seals, \*Oil rings, \*Blowby, \*Blowby devices, \*Molybdenum, \*Exhaust emission tests, \*Federal control, \*Oil consumption, \*Oils, \*Ash content, \*Pistons, \*Friction, \*Wear resistance, \*Wear tests, \*Reviews, \*Graphite, \*Exhaust emissions,

Progress in reducing emissions over the past eight years through improved piston ring designs and compatible facings is reviewed. The green engine effect is discussed and the use of reduced-friction piston rings to yield assembly-line emissions test results more nearly representative of the emissions from an engine after extended break-in running is suggested. The use of zero blowby piston rings to reduce oil contamination by extending oil change intervals and also to reduce emission is proposed. New piston ring facings may also play a part in improving durability and compatibility when ashless oils are specified and when the piston rings must be mounted at the top of the piston.  
HS-012 713

**ROAD RATING TRENDS OF UNITED STATES MOTOR CARS--A REVIEW OF RECENT CRC PROGRAMS**

Texaco, Inc.  
B. S. BaileyE. J. ForesterW. E. MorrisSAE-730012  
Presented at International Automotive Engineering Congress, Detroit, 8-12 Jan 1973.  
SAE

\*Octane ratings, \*Fuel composition, \*Gasoline quality, \*Road tests, \*Performance tests, \*Octane requirements, \*Transmission design, \*Variance analysis, \*Forecasting, \*Regression analysis, \*Parameters, \*Engine speeds, \*Tetraethyl lead, \*Hydrocarbons,

A review of the Coordinating Research Council road rating programs conducted between 1952 and 1971 indicates that: equations based on research octane number (RON) and motor octane number (MON) are satisfactory for predicting the road octane numbers of gasolines; MON has become more important and RON less important in prediction equations; variables such as percent aromatics, tetraethyl lead concentration, and dis-

tribution octane number are not broadly significant and improve RON/MON equation predictions only in restricted applications; car appreciation of low-sensitivity fuels has increased, while appreciation of high-sensitivity fuels has decreased; road octane response to increase in laboratory octane quality has decreased; variability of road octane testing and predictions have remained substantially constant over the past 20 years; and because of variability considerations, measurements of road versus laboratory octane relationships and estimates of car satisfaction are subject to significant errors.  
HS-012 719

**ORI IN 1971 MODEL CARS--WITH AND WITHOUT LEAD**

Gulf Res. and Devel. Co.  
Jr., H. A. BigleyJ. D. BensonSAE-730013  
Presented at International Automotive Engineering Congress, Detroit, 8-12 Jan 1973.  
SAE

\*Octane requirements, \*Leaded gasoline, \*Lead free gasoline, \*Low lead gasoline, \*Gasoline quality, \*Performance tests, \*Automobile models, \*Antiknock ratings, \*Vehicle mileage,

During 1970-1971, 15 organizations participated in a Coordinating Research Council program to compare the influence of unleaded and leaded gasolines on octane requirement increase (ORI). A total of 147 1971 model cars (47 pairs and 53 individual cars) were operated for 8,000-20,000 miles using driving schedules prescribed by each participant. One car of each pair was run on an unleaded fuel of 91-95 research octane number (RON) and the other on a leaded fuel of similar quality. For paired cars, the average ORI was 5.8 RON for unleaded and 3.8 RON for leaded fuel cars. The ORI difference of 2.0 RON for paired cars was slightly less than the average ORI difference of 2.5 RON for all 75 unleaded and 48 leaded cars. In a supplemental program, results in 20 cars showed an average ORI difference of only 0.3 RON between unleaded and low lead fuel cars.  
HS-012 720

**GASOLINE LEAD ADDITIVE AND COST EFFECTS OF POTENTIAL 1975-1976 EMISSION CONTROL SYSTEMS**

Aerospace Corp.  
Jr., M. G. HintonT. IuraJ. MeltzerJ. H. SomersSAE-730014  
Contract EPA-F-04701-71-C-017  
Presented at International Automotive Engineering Congress, Detroit, 8-12 Jan 1973.  
SAE

\*Exhaust emission control devices, \*Catalytic converters, \*Exhaust gas recirculation, \*Thermal reactors, \*Leaded gasoline, \*Lead free gasoline, \*Air pollution control costs, \*Performance tests, \*Exhaust emission control device tests, \*Durability tests, \*Corrosion, \*Durability, \*Exhaust emission standards, \*Exhaust emission tests, \*Service life, \*Nitrogen oxides, \*Hydrocarbons, \*Carbon monoxide, \*Engine modification, \*Maintenance costs, \*Parts costs, \*Fuel costs, \*Fuel economy,

A study was conducted to assess the overall effects of leaded gasoline on the performance, durability, and costs of emission control devices which might be used to meet the 1975-1976 federal emission standards. Currently planned 1975-1976 emis-

sion control systems include a catalytic converter. Lead additives are toxic to catalytic materials; they reduce catalytic activity, which results in increasing emission levels with mileage accumulation. Unleaded gasoline would be required in quantities sufficient to satisfy the demands of vehicles equipped with a catalytic converter. Implementation of such emission control systems implies high cost to the consumer, with the cost being a strong function of the required nitrogen oxides emission level. Estimated overall costs to the consumer are \$860 above average 1970 vehicle costs, over an 85,000-mile vehicle lifetime. This estimate is based on a system incorporating a dual catalytic converter, a low-grade rich thermal reactor, and exhaust gas recirculation.

HS-012 721

### AIR-COOLED ROTARY ENGINES--A FUELS AND LUBRICANTS STUDY

Army Fuels and Lubricants Res. Lab.

For primary bibliographic entry see Fld. 5D.

HS-012 737

### LUBRICANT AND FUEL REQUIREMENTS AND GENERAL PERFORMANCE DATA OF WANKEL ROTARY PISTON ENGINES

BP Benzin und Petroleum A.G. (West Germany)

R. D. Behling E. Weise SAE-730048

Presented at International Automotive Engineering Congress, Detroit, 8-12 Jan 1973.

SAE

\*Wankel engines, \*Lubricating oils, \*Oil seals, \*Wear resistance, \*Octane requirements, \*Apex seal, \*Detergency, \*Engine deposits, \*Oxidation, \*Preignition, \*Ash content, \*Viscosity, \*Performance tests, \*Wear tests, \*Engine design, \*Air cooled engines, \*Water cooled engines,

Lower octane requirements, lower nitrogen oxides emission, and lower space and weight requirements are assets of the rotary piston (RP) engine. The RP engine has performed satisfactorily with conventional engine oils developed for reciprocating engines, and the wear problem is largely solved. In order to prevent premature engine damage or failure, the preignition susceptibility of the RP engine must be reduced. Possible solutions presented are low content of ash precursors in the lubricant, selection of optimum base oil components, and design modifications.

HS-012 739

### INTERNATIONAL AUTOMOBILE TECHNICAL CONGRESS OF FIATA (14TH) 25-30 JUNE 1972, LONDON

Institution of Mechanical Engineers (England)

Includes HS-012 744--HS-012 808.

Corporate author

\*Vehicle noise, \*Exhaust emissions, \*Vehicle safety, \*Propulsion systems, \*Commercial vehicles, \*Petroleum industry, \*Economic analysis, \*Noise control, \*Exhaust emission control, \*Conferences, \*Vehicle design,

Aspects of vehicle noise and emissions and their control, vehicle safety, commercial vehicle power plants, the future role of

the petroleum industry, and overall vehicle costs are discussed in detail in a series of papers.

HS-012 743

### NOISE FROM DIESEL FUEL INJECTION EQUIPMENT

For primary bibliographic entry see Fld. 2G.

HS-012 750

### TECHNIQUES FOR REDUCING EXHAUST EMISSIONS FROM DIESEL ENGINES

D. Lyon J. M. Timms K. Muller Paper - 2/1

See serial citation

\*Diesel engine exhaust emissions, \*Exhaust emission control, \*Diesel fuels, \*Fuel composition, \*Exhaust composition, \*Fuel volatility, \*Boiling points, \*Cetane number, \*Fuel additives, \*Specific gravity, \*Ash content, \*Dual fuel vehicles, \*Fuel injection, \*Injection timing, \*Liquified petroleum gases, \*Smoke, \*Nitrogen oxides, \*Hydrocarbons, \*Engine design, \*Engine modification, \*Exhaust emission tests,

Diesel engine emission standards are being met by adjusting existing power units. Mechanical modifications to engines can reduce individual emission components but usually at the expense of increases in other pollutants. Changes in diesel fuel quality can also lower individual pollutant levels, but may not have the same effect in all engines. Anti-smoke additives are effective, but commercial acceptance has been limited. To reduce overall emission levels, engine and fuel should be treated as a single system. The use of dual fuelling with liquified petroleum gas in conjunction with retarded injection timing, can reduce both smoke and nitrogen oxides.

HS-012 758

### RUSSBILDUNG IN OTTO-MOTOREN (SOOT-FORMATION IN SPARK-IGNITION ENGINES)

H. O. Hardenberg H. Daudel Paper - 2/2

Text in German.

See serial citation

\*Spark ignition engines, \*Soot, \*Deposition, \*Combustion chamber deposits, \*Combustion products, \*Fuel combustion, \*Fuel injection, \*Injection timing, \*Fuel composition, \*Fuel additives, \*Methanols, \*Knock, \*Smoke, \*Air fuel ratio, \*Paraffins, \*Mathematical analysis, \*Engine tests, \*Exhaust emissions, \*Unburned fuels,

Soot formation in gasoline engines is produced by retarded injection timing and increases with greater retarding until a smoke characteristic corresponding to that of the diesel engine occurs. The type of mixture formation affects the amount of soot formed. Combustion processes with low compression ratios produce less soot than the M-process with fuel deposition on the combustion chamber wall. The influence of fuel on soot formation was investigated. Methanol proved an effective anti-smoke additive with paraffin fuel but not with the M-process. Tests showed that smoke occurs when combustion takes place where there is an excess air ratio of 0.25-0.75:1 in the combustion chamber and not when fuel is unevaporated upon ignition. Soot formation reduced carbon monoxide emission and had an anti-knocking effect. Knocking combustion increased soot formation. Soot deposition on the combustion chamber walls is illustrated.



**Group 5F—Fuel Systems**

HS-012 759

**DIESEL OIL AND L.P.G. FUEL FEED OF I.C. ENGINES TO REDUCE URBAN BUS EXHAUST SMOKINESS**C. MartiniM. OggeroPaper - 2/3  
See serial citation

\*Diesel engines, \*Liquefied petroleum gases, \*Buses, \*Exhaust emission control, \*Dual fuel vehicles, \*Fuel injection, \*Injection timing, \*Exhaust emission measurement, \*Hydrocarbons, \*Carbon monoxide, \*Nitrogen oxides, \*Smoke, \*Bus tests, \*Exhaust emission tests, \*Road tests, \*Fuel composition, \*Loading (mechanical), \*Parameters, \*Exhaust emission standards, \*Engine performance, \*Engine tests, \*Italy,

Experiments performed on urban bus diesel engines showed the possibility of reducing exhaust smokiness by a dual fuel system limiting diesel oil delivery to about 70% of full load and making up for this limitation by introducing liquefied petroleum gases (LPG) into the conventional intake manifold. The above diesel oil and LPG percentages represent the best compromise between the goal in view and the requirements of avoiding engine operational roughness, limiting increases in other emissions, and limiting the bulk of LPG tanks on the vehicle. The first engine so equipped favorably passed a period of experimental operation on a bus in regular service. Test and emission measurement procedures are described.

HS-012 760

**MECHANICAL AND CATALYTIC ROUTES TO LOW-EMISSION PASSENGER CARS**W. E. AdamsH. J. GibsonD. A. HirschlerJ. S. WintringhamPaper - 2/4  
See serial citation

\*Exhaust emission control, \*Carburetor design, \*Exhaust manifold reactors, \*Exhaust gas recirculation, \*Catalysts, \*Lean fuel mixtures, \*Particulate traps, \*Engine modification, \*Low emission vehicles, \*Air fuel ratio, \*Compression ratio, \*Catalyst tests, \*Hydrocarbons, \*Carbon monoxide, \*Nitrogen oxides, \*Fuel economy, \*Spark timing,

The engines in the Ethyl lean-reactor cars operate with air-fuel mixture ratios considerably leaner than stoichiometric through the use of a specially developed, high-velocity carburetor that gives excellent mixture homogeneity. The lean well-prepared mixtures produce relatively little hydrocarbons, carbon monoxide (CO), or nitrogen oxides (NOx). The small amounts of combustibles remaining are further oxidized by the 2-4% oxygen in the exhaust gas, aided by heat-conserving techniques in the exhaust systems. Emissions of NOx are further reduced by using exhaust gas recirculation. Spark advance characteristics are tailored for the best compromise between fuel economy, driveability, and low emissions. Compared with precontrol cars, lean-reactor cars reduce hydrocarbons by 94-96%, CO by 91-95%, and NOx by 79-88%. Catalysts have been found that are resistant to antiknock compounds and fuel sulfur compounds, but none has been found that meets future standards and is sufficiently resistant to attrition to perform satisfactorily.

HS-012 761

**EXPERIMENTAL ANALYSIS ABOUT THE EFFECT OF ENGINE DESIGN FACTORS ON EXHAUST EMISSIONS**Y. SakaiH. MiyazakiS. TsutsumiK. MukaiPaper - 2/5  
See serial citation

\*Engine design, \*Exhaust emissions, \*Exhaust emission test, \*Exhaust emission sampling, \*Air fuel ratio, \*Combustion chambers, \*Compression ratio, \*Engine operating conditions, \*Unburned hydrocarbons, \*Temperature, \*Fuel consumption, \*Exhaust emission control, \*Mathematical analysis, \*Nitric oxide,

Experiment and analysis using a single cylinder engine were conducted concerning the effect of stroke volume, stroke bore ratio, and compression ratio on exhaust emissions, taking into consideration engine operating factors. At constant charging efficiency and air fuel ratio, hydrocarbon concentration increases almost in proportion to the combustion chamber surface area to volume ratio (S/V) which is determined by design factors. At a constant compression ratio, nitric oxide (NO) concentration decreases with the increase of S/V ratio. A higher compression ratio, that is, the combustion chamber which has a higher thermal efficiency, increases NO concentration. At constant output and fuel consumption, larger stroke bore ratio reduces NO mass emission. The effect of compression ratio on NO is small and there exists some region where a higher compression ratio reduces NO mass emission. Test results are presented graphically.

HS-012 762

**THE EFFECT OF DIRECT-CYLINDER WATER INJECTION ON NITRIC OXIDE EMISSION FROM A S.I. ENGINE**S. S. LestzW. E. MeyerPaper - 2/6  
Conducted in part under a research grant from the Environmental Protection Administration.  
See serial citation

\*Exhaust emission control, \*Water injection, \*Spark ignition engines, \*Nitric oxide, \*Mathematical models, \*Combustion, \*Spark timing, \*Power loss, \*Pressure time histories, \*Heat transfer, \*Cylinder gases, \*Specific heat, \*Injection timing, \*Brake torque, \*Engine operating conditions, \*Water fuel ratio

Results of an investigation into the effects of direct-cylinder water injection on spark ignition engine combustion are presented. It was found that: nitric oxide (NO) reductions of 80% are obtained for constant spark timing operation with an accompanying power deterioration in excess of 25%; for constant spark advance operation, the change in the phasing of the combustion resulting from a longer initial burn duration is primarily responsible for the NO reduction; maximum brake torque (MBT) operation for moderate injection levels maintains a constant phasing of the combustion with 70% NO reduction and with power sacrifices of 5 to 10%; the data appear to support the theoretical model that predicts a linear relationship between the change in spark timing required to produce MBT with and without diluent and the water fuel ratio (W/R); and MBT operation, pressure-time diagrams for various W/R's indicate a constant phasing of the combustion.

HS-012 763

**MOGLICHKEITEN ZUR VERMINDERUNG DER STICKOXYDBILDUNG IN OTTO-MOTOREN INSBESONDERE DURCH SCHICHT-LADUNGSBETRIEB UND KATALYTISCHE KONVERTIERUNG (POSSIBILITIES OF REDUCING NITROGEN-OXIDE FORMATION IN SPARK-IGNITION ENGINES, ESPECIALLY BY STRATIFIED-CHARGE OPERATION AND CATALYTIC CONVERSION)**

H. Heitland W. Bernhardt Paper - 2/7  
Text in German.  
See serial citation

\*Nitrogen oxides, \*Spark ignition engines, \*Exhaust emission control, \*Combustion, \*Mathematical models, \*Exhaust gases, \*Catalytic converters, \*Oxidation catalysts, \*Ammonia, \*Combustion products, \*Carbon monoxide, \*Hydrocarbons, \*Oxygen, \*Stratified charge engines, \*Precombustion chamber engines,

Nitrogen oxide emission reduction in a spark ignition engine produces increased fuel consumption, reduced output, and poor driveability. Changes in combustion mixture-charging processes, such as stratified charging by a precombustion chamber system, can reduce nitrogen oxide concentrations. Catalytic conversion of nitrogen oxides liberates the oxygen at the catalyst surface and it is used for oxidizing carbon monoxide and light hydrocarbons. The proportion of oxygen in the exhaust gas must be less than that required for complete oxidation of carbon monoxide. With a carbon monoxide/oxygen ratio greater than 2:1, nitrogen oxide conversion is good, but ammonia formation increases, and the ammonia is converted primarily into nitrogen oxide in an adjoining hydrocarbon/carbon monoxide catalyst. The mathematical models used are described in detail.

HS-012 764

**WIEWEIT KANN NO<sub>x</sub> MIT REICHEN GEMISCHEN SENKEN? (HOW FAR CAN NITROGEN OXIDES BE REDUCED WITH RICH MIXTURES?)**

G. Chone H. Oetting Paper - 2/8  
Text in German.  
See serial citation

\*Exhaust emission control, \*Exhaust gas recirculation, \*Ignition timing, \*Air fuel ratio, \*Engine modification, \*Nitrogen oxides, \*Hydrocarbons, \*Carbon monoxide, \*Fuel consumption, \*Rich fuel mixtures, \*Exhaust emission tests,

Laboratory experiments were carried out with the object of reducing nitrogen oxides emissions from a production-car engine as far as possible, without increasing carbon monoxide (CO) and hydrocarbon (HC) emissions, by exhaust gas recirculation (EGR) and alterations to ignition timing and air fuel ratio. Tests showed that, with an air fuel ratio of 1.0, nitrogen oxides could be reduced to the 1976 limits at the expense of a 7-33% increase in fuel consumption and a 7-25% reduction in mean effective pressure (mep). Nitrogen oxides emissions can be reduced to 40% of 1971 values, however, with EGR volumes of 10-15% of intake air volume and modified ignition timing without detriment to HC and CO emissions, fuel consumption, or mep. Relatively simple control devices serve to link EGR

volume and ignition advance with carburetor throttle-valve setting. Application of these methods to series production is still a remote prospect, particularly because of the shortening of engine life and problems with the increase in accelerator-pedal forces.

HS-012 765

**DIE-STICKOXIDBILDUNG IM OTTO-MOTOR (NITROGEN-OXIDE FORMATION IN SPARK-IGNITION ENGINES)**

G. Schwarzbauer D. Gruden Paper - 2/9  
Text in German.  
See serial citation

\*Nitric oxide, \*Spark ignition engines, \*Thermodynamic analysis, \*Combustion, \*Unburned fuels, \*Air fuel ratio, \*Exhaust emission tests, \*Compression ratio, \*Exhaust emission control, \*Lean fuel mixtures, \*Temperature, \*Mathematical analysis,

A method for thermodynamic evaluation of spark ignition engines has been developed which permits calculation of heat supplied to the charge, the proportion of burned charge in the total charge, the mean temperatures of total, unburned, and burned charges, and the temperature gradient in the burned charge. It is estimated that 2% of the cylinder charge remains unburned during nitric oxide formation and that the atomic oxygen content is five times that of the equilibrium condition. Allowing for this, a satisfactory correlation is found throughout the air fuel ratio range. Cyclic variations in mean effective pressure and nitric oxide concentration produced by lean fuel mixtures are calculated. If perfect regularity of combustion could be ensured, nitric oxide emissions could be reduced by one-third without detriment to mean effective pressure or fuel economy.

HS-012 766

**A VARIABLE LIFT AND EVENT CONTROL DEVICE FOR PISTON ENGINE VALVE OPERATION**

For primary bibliographic entry see Fld. 5D.  
HS-012 767

**5G. Glazing Materials**

**THE EFFECT OF LIGHT ABSORBING MEDIA ON DRIVER VISUAL PERFORMANCE. FINAL REPORT**

Brown Engineering Co., Inc.  
For primary bibliographic entry see Fld. 3L.  
HS-800 815

**5I. Inspections**

**AUTOMOTIVE HEADLAMP AIMING--INTENTIONS AND RESULTS**

Virginia State Police  
For primary bibliographic entry see Fld. 5J.  
HS-012 714

**AUTOMOTIVE HEADLAMP AIMING AS APPLIED AT THE MOTOR VEHICLE INSPECTION STATION**

South Dakota Hwy. Patrol  
D. Eissnach SAE-730008  
Presented at International Automotive Engineering Congress, Detroit, 8-12 Jan 1973.  
SAE

**Field 5—VEHICLE SAFETY****Group 5I—Inspections**

\*Headlamp aiming, \*Vehicle inspection, \*Lighting inspection, \*Inspection procedures, \*Inspection stations, \*Inspection equipment, \*Inspector training, \*South Dakota, \*Attitudes,

The variables involved in aiming of headlamps in nonlaboratory conditions are discussed: qualifications of personnel, the physical plant, equipment, the consumer, and the vehicle itself. Suggested improvements include the establishment of uniform regulations to control the physical characteristics of the inspection area, supervision and education of the inspection personnel, and the design of a superior adjusting mechanism. In addition, efforts should be made to approve the use of mechanical aiming devices in all jurisdictions; vehicle manufacturers should develop a practical method to stabilize the reaction of the suspension system to the many loading conditions of the vehicle; vehicle manufacturers, in the adjustment of the headlamp aim on the assembly line, should simulate a uniform anticipated load; and the states should provide an efficient and effective periodic inspection program supplemented with a realistic vehicle equipment enforcement program.

HS-012 715

**PROBLEMS IN PASSENGER CAR HEADLAMP AIM**

California Dept. of Hwy. Patrol

For primary bibliographic entry see Fld. 5J.

HS-012 716

**COMPATIBILITY OF HEADLAMP AIM AND INSPECTION**

General Motors Corp.

For primary bibliographic entry see Fld. 5J.

HS-012 717

**5J. Lighting Systems****AUTOMOTIVE HEADLAMP AIMING--INTENTIONS AND RESULTS**

Virginia State Police

R. M. TerrySAE-730007

Presented at International Automotive Engineering Congress, Detroit, 8-12 Jan 1973.

SAE

\*Headlamp aiming, \*Virginia, \*Vehicle inspection, \*Headlamp regulations, \*Regulation enforcement, \*Inspector training, \*Police training, \*Police law enforcement responsibilities, \*Lighting inspection,

Problems encountered on the state level in enforcing regulations regarding the accurate aiming of motor vehicle headlamps are outlined. State regulations and their enforcement vary throughout the United States. The state of Virginia has taken a number of steps to ensure that the headlamps on vehicles operating within the state are the best possible: training and retraining of inspectors; improved supervision of the inspection process; adaptation of the aiming tolerances allowed in SAE J599, Lighting Inspection Code; and a constant awareness that state officials must keep up to date with changes in the technology and engineering of lighting devices.

HS-012 714

**AUTOMOTIVE HEADLAMP AIMING AS APPLIED AT THE MOTOR VEHICLE INSPECTION STATION**

South Dakota Hwy. Patrol

For primary bibliographic entry see Fld. 5I.

HS-012 715

**PROBLEMS IN PASSENGER CAR HEADLAMP AIMING**

California Dept. of Hwy. Patrol

W. M. HeathSAE-730009

Presented at International Automotive Engineering Congress, Detroit, 8-12 Jan 1973.

SAE

\*Headlamp aiming, \*Headlamp alignment, \*Lighting inspection, \*Inspection equipment, \*Measuring instruments, \*Beam headlamps, \*California, \*Low beamed headlamps, \*Beamed headlamps, \*Lamp housings, \*Headlamp regulations, \*Headlamp mounting height, \*Headlamp design, \*Inspection procedures,

Maintenance and inspection of correct aim of headlamps has been a perennial problem that involves unstable mounting, imprecision in inspecting equipment, various sealed beam units, and improper initial aim of lamp units on vehicles. These areas of the headlamp aim problem have been discussed and some solutions are suggested. The cooperative Federal, state, and industry effort on all headlamp aim is emphasized.

HS-012 716

**COMPATIBILITY OF HEADLAMP AIM AND INSPECTION**

General Motors Corp.

J. W. MurphySAE-730010

Presented at International Automotive Engineering Congress, Detroit, 8-12 Jan 1973.

SAE

\*Headlamp aiming, \*Vehicle inspection, \*High beam headlamps, \*Low beamed headlamps, \*Lighting inspection, \*Headlamp tests, \*Government industry cooperation, \*Inspection equipment,

The requirements and disadvantages of the three headlamp aiming methods now employed, visual aiming on a 25 foot target, mechanical aimers, and headlamp testing machine methods are presented. Charts indicate the accuracy of each method and the probability of acceptance of a unit that is aimed visually and inspected by another method is determined. Work in the field and future considerations are summarized.

HS-012 717

**HEADLAMP AIM CORRECTING DEVICES**

Lucas (Joseph) (Electrical) Co. Ltd. (England)

K. J. JonesA. M. MacMillanSAE-730011

Presented at International Automotive Engineering Congress, Detroit, 8-12 Jan 1973.

SAE

\*Headlamp aiming, \*Suspension systems, \*Headlamp aiming, \*Mathematical analysis, \*British vehicles, \*Headlamp standards, \*Headlamp aim correcting devices,

The need for accurate headlamp aim is examined and the performance requirements of automatic aim-correcting devices and the performance of a specific arrangement now being experimentally to a number of British cars are considered.

HS-012 718

## 5L. Manufacturers, Distributors, And Dealers

### METRICATION IMPACT IN THE FLUID POWER INDUSTRY

National Fluid Power Assoc.

J. I. MorganH. C. ParsonsH. Y. SmithSAE-730040

Presented at International Automotive Engineering Congress, Detroit, 8-12 Jan 1973.

SAE

\*Industries, \*Fluidics, \*Metric system, \*International compacts, \*Standardization, \*Manufacturing standards, \*Foreign trade, \*Conferences, \*Fluid power,

This three-part paper describes the experience of the fluid power industry in the making of international standards through the International Standards Organization (ISO). The first section outlines the National Fluid Power Association's approach to the problem, and the necessity for the industry to adopt the international standard of metric units as the language of measurement in the United States. The second part describes the workings of an ISO committee. The last section shows how United States standards (specifically SAE's) are viewed by other delegations to ISO committees. The consensus is that international standardization is essential to all countries' economic interests, and that the United States must participate strongly in the work of ISO if her industry is to remain competitive for the indefinite future.

HS-012 733

## 5N. Occupant Protection

### TEST AND EVALUATION OF THE AMF INC. AND FAIRCHILD INDUSTRIES EXPERIMENTAL SAFETY VEHICLES. VOL. 1. ESV PROGRAM SUMMARY. FINAL REPORT

Dynamic Science

For primary bibliographic entry see Fld. 5D.

HS-800 783

### TEST AND EVALUATION OF THE AMF INC. AND FAIRCHILD INDUSTRIES EXPERIMENTAL SAFETY VEHICLES, VOL. 4. ESV PROGRAM SUMMARY. FINAL REPORT

Dynamic Science

For primary bibliographic entry see Fld. 5D.

HS-800 786

## 5Q. Safety Defect Control

### MOTOR VEHICLE SAFETY DEFECT RECALL CAMPAIGNS REPORTED TO THE NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION BY DOMESTIC AND FOREIGN VEHICLE MANUFACTURERS, JANUARY 1, 1972 to DECEMBER 31, 1972

National Hwy. Traf. Safety Administration

GPO

\*Recall campaigns, \*Automobile recall campaigns, \*Truck recall campaigns, \*Trailer recall campaigns, \*Tractor recall campaigns, \*Motorcycle recall campaigns, \*Tire recall campaigns, \*School bus recall campaigns, \*Child safety seats, \*King pins, \*Axle brakes, \*Defect correction, \*Statistics, \*Defective vehicles, \*Defective tires, \*Automobile models,

This tabulation of safety defect recall campaigns includes the make and model, model year, description of the defect requiring manufacturer's corrective action, number of vehicles recalled, date of notification, and identification number. Automobiles, trucks, trailers, tractors, motorcycles, school buses, tires, child safety seats, king pins, and electric axle brakes are included.

HS-820 248

## 5R. Steering Control Systems

### MEASURING CAR-DRIVER INTERACTION WITH THE g-g DIAGRAM

Calspan Corp.

For primary bibliographic entry see Fld. 3D.

HS-012 723

### SUSPENSION DESIGN TO REDUCE INTERNAL ROAD NOISE

J. F. HardenbergJ. EwinsP. GrootenhuisPaper - 1/5

See serial citation

\*Suspension systems, \*Vibration analysis, \*Mathematical models, \*Vibration isolators, \*Noise control, \*Damping, \*Resonant frequency, \*Vehicle riding qualities,

The transmission of road-generated vibrations into a vehicle body is considered as a source-path-receiver situation. The suspension acts as the path, and improved isolation can be obtained with a single compliant bush at the damper/body connecting point. A mathematical model is derived for such a system, and a contour map shows the influence of bush stiffness and damper coefficient on the parameter-optimization process. The optimum design point appears very sensitive to parameter variations, but there is a contour-map region for which the design conditions are nearly satisfied while permitting considerable damping-coefficient variation.

HS-012 748

### TEST AND EVALUATION OF THE AMF INC. AND FAIRCHILD INDUSTRIES EXPERIMENTAL SAFETY VEHICLES. VOL. 1. ESV PROGRAM SUMMARY. FINAL REPORT

Dynamic Science

For primary bibliographic entry see Fld. 5D.

HS-800 783

### TEST AND EVALUATION OF THE AMF INC. AND FAIRCHILD INDUSTRIES EXPERIMENTAL SAFETY VEHICLES, VOL. 3. ESV PROGRAM SUMMARY. FINAL REPORT

Dynamic Science

2310-72-23-Vol-3

Contract DOT-OS-10187

Report for Jul 1971-Aug 1972. Vol. 2 is HS-800 784; vol.4 is HS-800 786.

## Field 5—VEHICLE SAFETY

HSL 73, No. 12

### Group 5R—Steering Control Systems

#### NTIS

\*Experimental automobiles, \*Safety cars, \*Accident avoidance tests, \*Automobile handling, \*Vehicle control, \*Automobile performance, \*Brake tests, \*Steering tests, \*Lateral acceleration, \*Crosswind, \*Vehicle road interface, \*Turning radius, \*Rollover tests, \*Field of view, \*Visibility, \*Display systems, \*Control location, \*Engine tests, \*Lateral force, \*Vehicle riding qualities, \*Instrumentation, \*Test equipment, \*Data reduction, \*Calibration, \*Questionnaires, \*Yaw, \*Test facilities, \*Data acquisition, \*Automobile stability,

Two Experimental Safety Vehicles were tested for accident avoidance performance. Descriptions, procedures, and results are presented for tests of brake performance; steering control and performance, including steady state and transient yaw response and returnability; automobile handling, including fixed and manual control lateral acceleration, control at breakaway, and crosswind and pavement irregularity sensitivity; overturning immunity in J-turns and on pylon courses; field of view and clear glazing maintenance; lateral acceleration and determination of lateral force influence on vehicle performance; vehicle range; and riding characteristics. Test facilities and instrumentation used, data acquisition and reduction systems, and calibration procedures are described. Test results for both vehicles are compared.

HS-800 785

### 5T. Trucks And Trailers

#### THE EXPERIMENTAL STUDY OF TRUCK TIRE NOSE

For primary bibliographic entry see Fld. 5V.  
HS-012 754

### 5V. Wheel Systems

#### ADVANCES IN TIRE CORD PROCESSES. PT. 2: PROCESS TECHNIQUES

V105 N3

C. A. Litzler

Based on a paper presented at American Inst. of Chemical Engineers National Meeting (73rd), Minneapolis, 28 Aug 1972.  
See serial citation

\*Tire materials, \*Tire cords, \*Tire manufacture, \*Textiles, \*Fabrics, \*Wire, \*Drums, \*Heat treatment, \*Calendering,

Concurrent with the developments in the reinforcing materials, there have been several developments and improvements in tire cord processing techniques for the treatment of both wire and textile materials. Several rubberizing processes, including roller die system, and Compudrum system, are described. The Vari-Zone oven system, the hot rubber calendar system, cold rubber calendar system, a new approach to an efficient oven system for the adhesivizing and stretching treatment of rayon, nylon, polyester, and Fiber B under precisely controlled conditions of exposure time, temperature and heat transfer, is also discussed.

HS-012 705

#### CANTILEVER AIRCRAFT TIRES--MORE THAN A BREAK FOR BRAKES

Firestone Tire and Rubber Co.

San Diego, 2-5 Oct 1972.  
SAE

\*Aircraft tires, \*Cantilever tires, \*Tire design, \*Brake wear, \*Tire performance, \*Tire shape, \*Rims, \*Tire treads, \*Tire wear, \*Tensile strength, \*Tire deflection, \*Tire beads, \*Tire cords, \*Tire ply number, \*Brake design, \*High speed,

Cantilever tires offer the following advantages to aircraft users: larger ID rims for larger brakes or increased ventilation; increased tread life through increased tire flatness; better high-speed performance through low aspect ratio design; better durability, due to programmed ply ending zones; better weight to size ratio; due to low aspect ratio and simplified bead construction; 15 deg. rim with functional flange design; and possibility for future one-piece rim construction. This paper details the design philosophy and transitional processes by way of which this tire came to be available for aircraft service.

HS-012 706

#### TIRE DEVELOPMENT BY DEDICATED INVOLVEMENT

Goodyear Tire and Rubber Co.  
SAE-720869

Presented at National Aerospace Engineering and Mfg. Meeting, San Diego, 2-5 Oct 1972.  
SAE

\*Aircraft tires, \*Tire materials, \*Tire design, \*Tire retreading, \*Tire treads, \*Retreaded tires, \*Fibers, \*Nylon, \*Rubber compounds, \*Materials tests, \*Tire shape, \*Tire casings, \*Aspect ratio, \*Physical properties,

Improvements made in aircraft tires and possible future developments are discussed. Current nylon fiber may well be replaced with fiber B, a new organic material with high strength and high modulus. Compounds can be tested on accurate machines. Tread designs are changing to a centerline rib with four grooves. A new carcass shape in the lower sidewall area is discussed. Retreading practices are reviewed and it is shown that the unit price of new tires and retreaded tires has increased very little in relation to performance.

HS-012 707

#### THE EXPERIMENTAL STUDY OF TRUCK TIRE NOSE

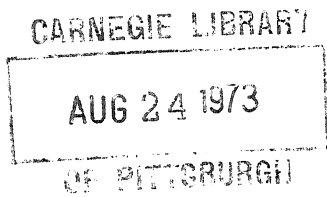
J. Sakagami Paper - 1/12  
See serial citation

\*Tire tires, \*Truck noise, \*Acoustic measurement, \*Sound intensity, \*Tire tread patterns, \*Tire inflation pressure, \*Road surfaces, \*Speed, \*Variance analysis, \*Loading (mechanical),

The following items regarding truck tire noise were investigated: influence of tire noise to total exterior noise; effects of vehicle speed, tread patterns, road surface, payload, and road wetness on tire noise; radiational characteristics of vehicle noise in motion; approximate acoustic power of vehicle noise in motion; relation between vehicle speed and tire noise; and noise level emitted by the various types of vehicles. Also a test procedure for tire road noise was proposed and a trial on the vehicles to reduce tire noise was given. It was concluded that tire noise of lug patterns is the predominant noise source at high speed range, so it is desirable to use other tire patterns; and the higher the tire pressure and the lighter the payload, the more

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